MANAGING VOLCANIC IMPACTS IN CANTERBURY

Tom Wilson
University of Canterbury & Natural Hazard Research Platform

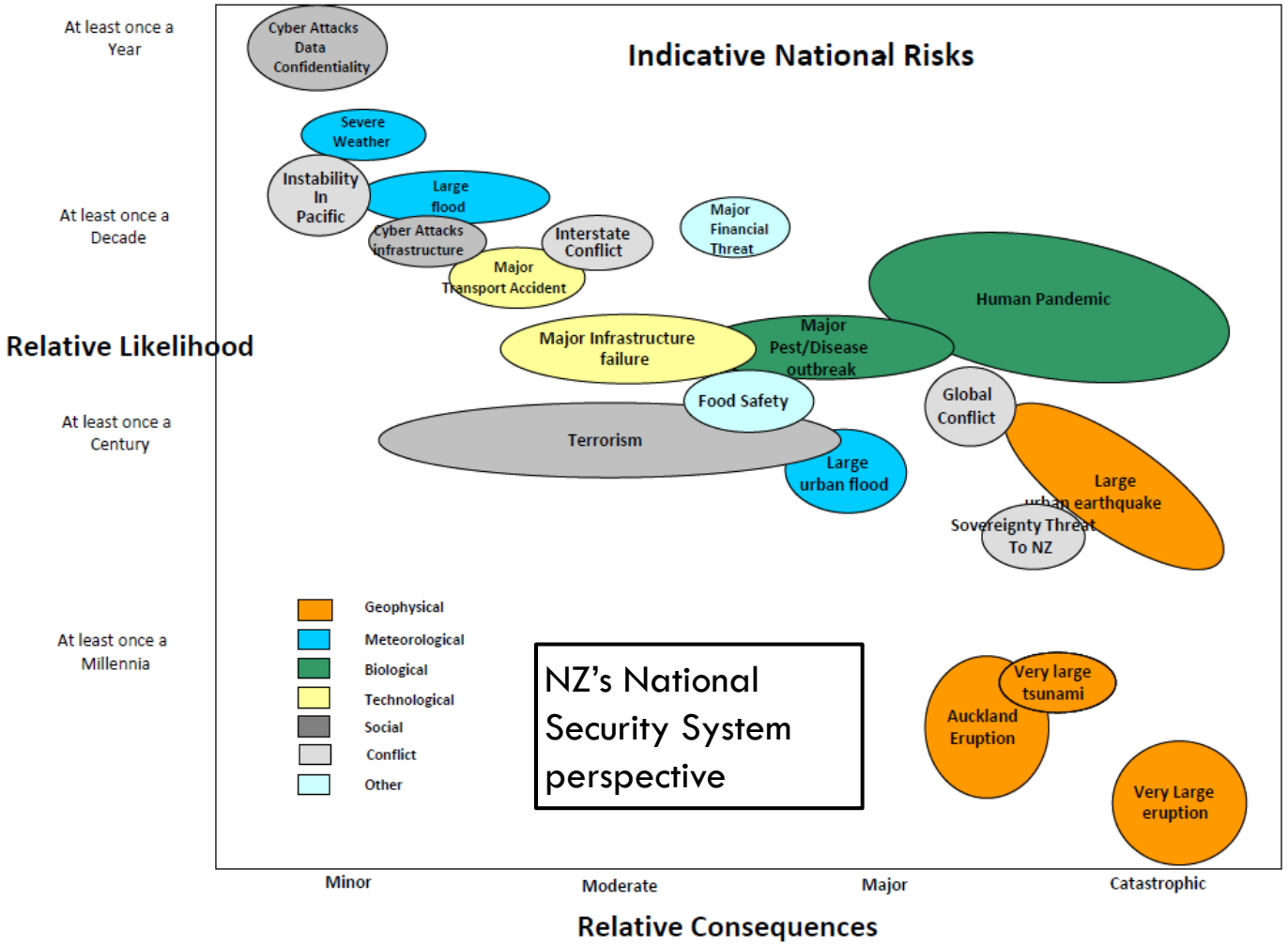
Talk Outline

- Risk of a Volcanic eruption affecting Canterbury
  - Putting it in context (likelihood/consequence)
  - Volcanic Hazards in New Zealand
  - Has Canterbury received volcanic ash fall before?
- Scenarios which might impact Canterbury CDEM group
- Scientific Arrangements for a Volcanic Eruption
  - GeoNet products
  - Ash Impact Assessment
  - Ash Impact preparedness and mitigation resources

Thanks to Cam Asher (UC) for drafting figures

What are the natural hazards?

generally the extreme events are the ones that have the major impacts

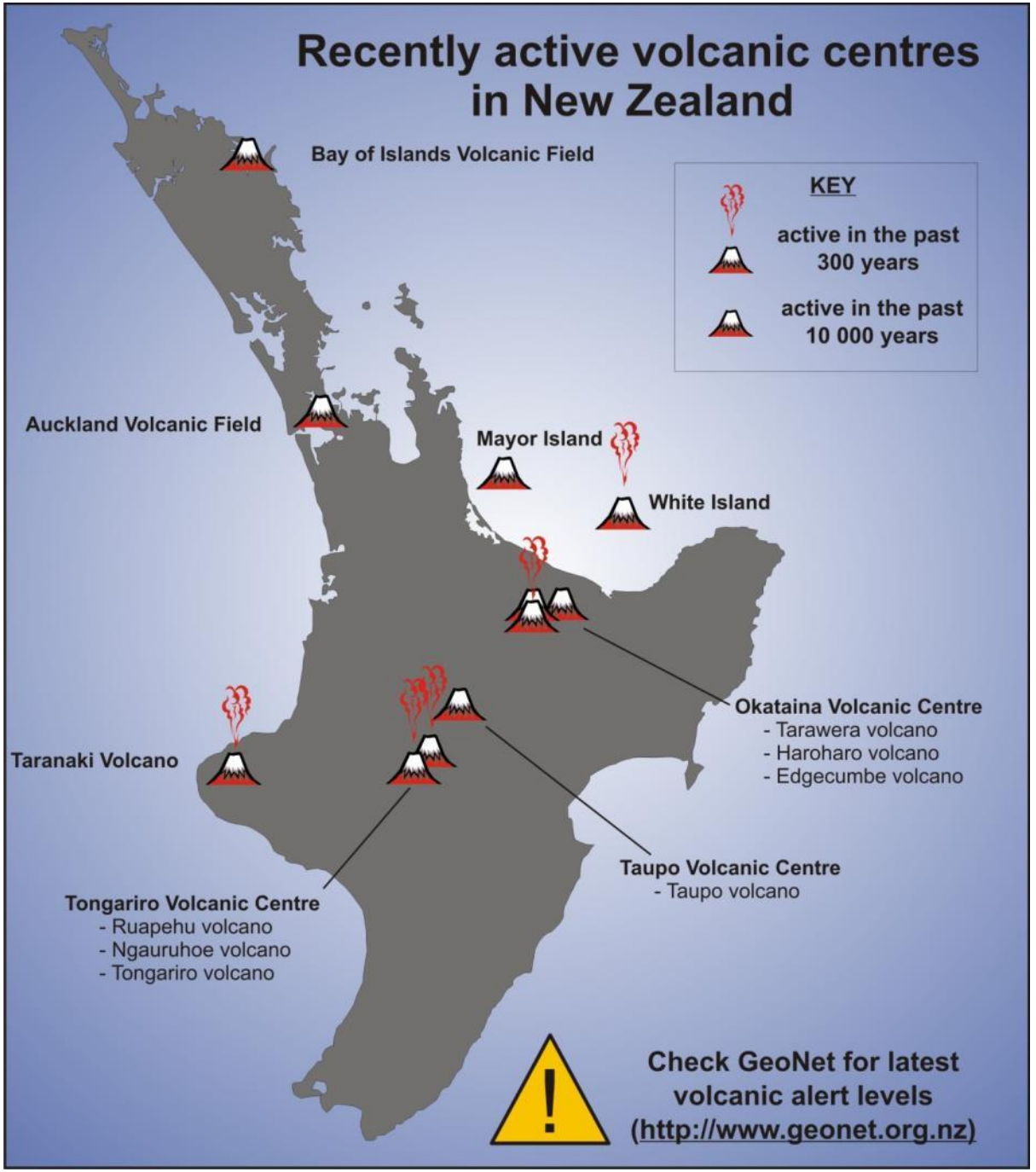


http://www.dpmc.govt.nz/sites/all/files/publications/national-security-system.pdf

Looking Forward
What should we be preparing for?

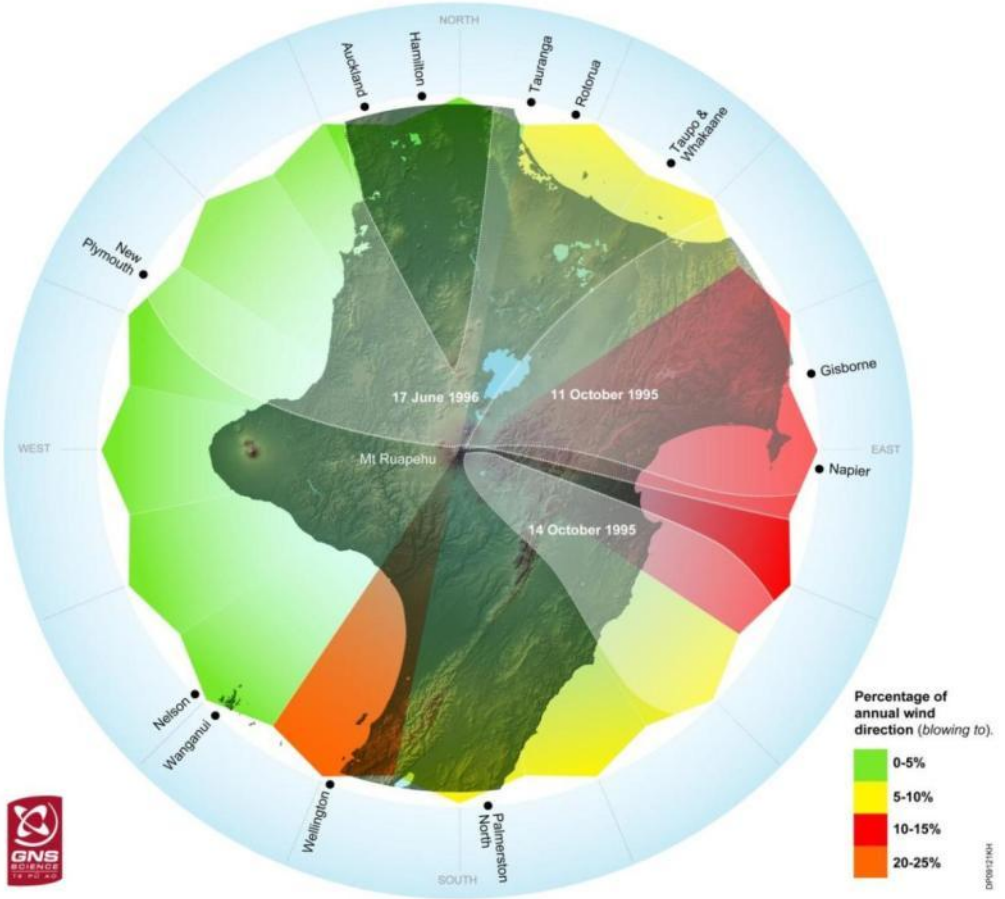
Event	Likelihood in next 50 yrs	Possible economic loss (2012 estimates)
• Alpine fault - M8 earthquake	30%	> $10bn?
• Ruapehu/Tongariro/Ngauruhoe White Island major eruption	almost certain	> $100M
• Taranaki eruption	20%	~ $1bn ?
• Hikurangi subduction zone M8+ and tsunami	10%	> $10bn
• Hope fault M7.2 earthquake	50%	~$1bn ?
• South America M9+ earthquake & NZ tsunami	50%	>$1bn ?
• Taupo region major eruption	10%	> $10bn
• Auckland volcanic eruption	5%	>> $10bn
• NZ earthquake sequence like 1929-1942	50%	>> $10bn

Kelvin Berryman, Natural Hazards Research Platform


Recently active volcanic centres in New Zealand
Bay of Islands Volcanic Field
KEY
active in the past 300 years
active in the past 10 000 years
Auckland Volcanic Field
Mayor Island
White Island
Okataina Volcanic Centre
- Tarawera volcano
- Haroharo volcano
- Edgecumbe volcano
Taranaki Volcano
Taupo Volcanic Centre
- Taupo volcano
Tongariro Volcanic Centre
- Ruapehu volcano
- Ngauruhoe volcano
- Tongariro volcano
Check GeoNet for latest volcanic alert levels
(http://www.geonet.org.nz)

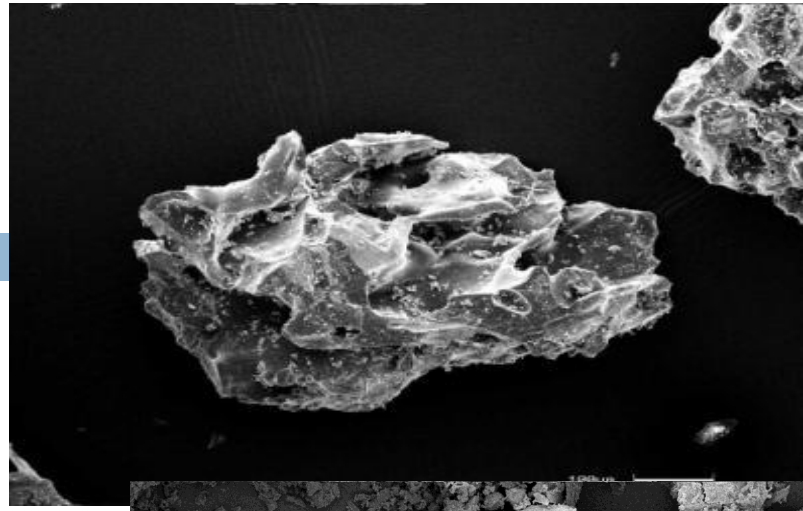
Volcanic ash

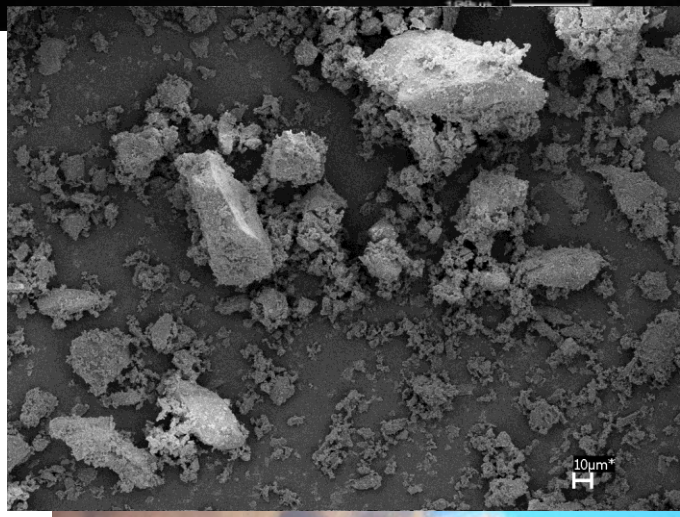
- Widespread, variable distribution
- <100 mm ash fall: Low intensity impacts (disruptive)



Ash properties

- Ash is produced by explosive eruptions (magma fragmentation)
- Ash is typically:
  - Highly abrasive (hard, angular)
  - Has a surface coating of soluble salts which can make it electrically conductive and corrosive
- Ash is variable (colour, density, surface chemistry, particle morphology ..)





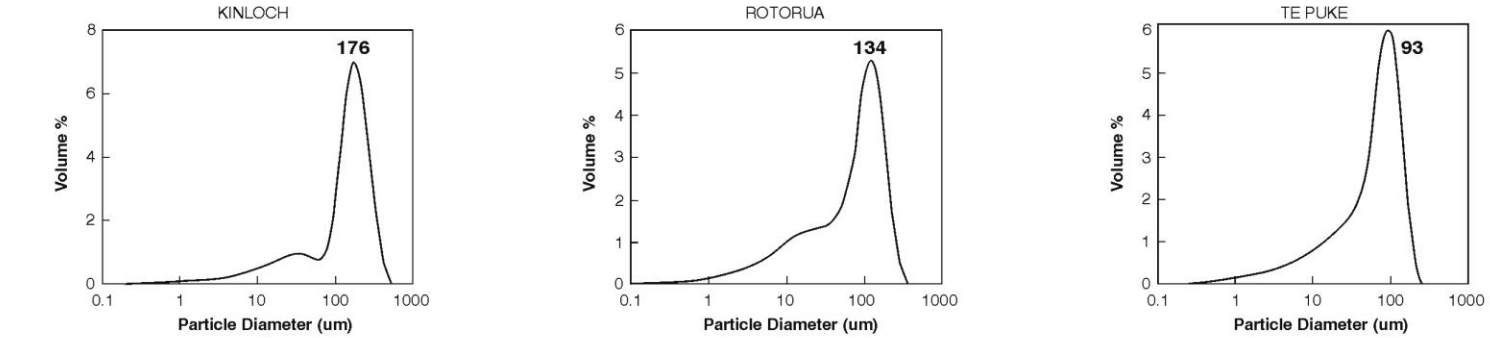
Variable nature of tephra

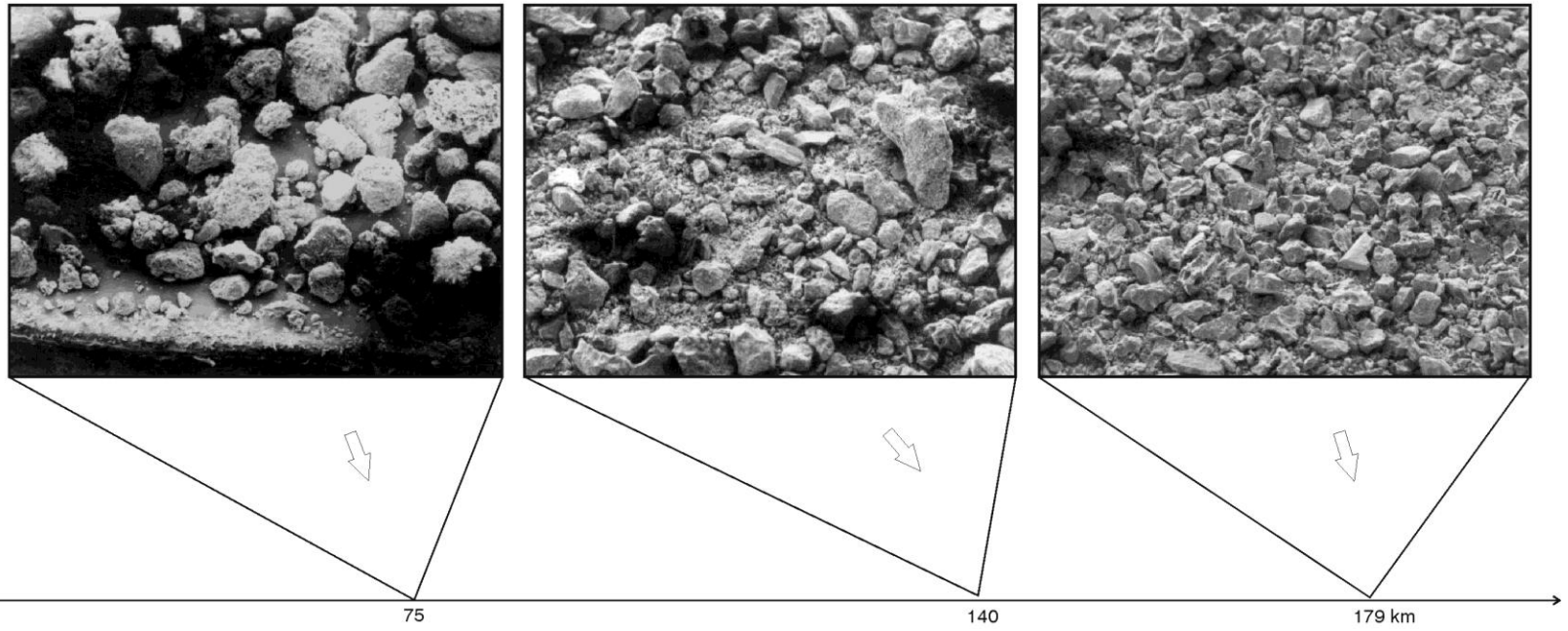
Rhyolite ash, Chaitén volcano, Chile

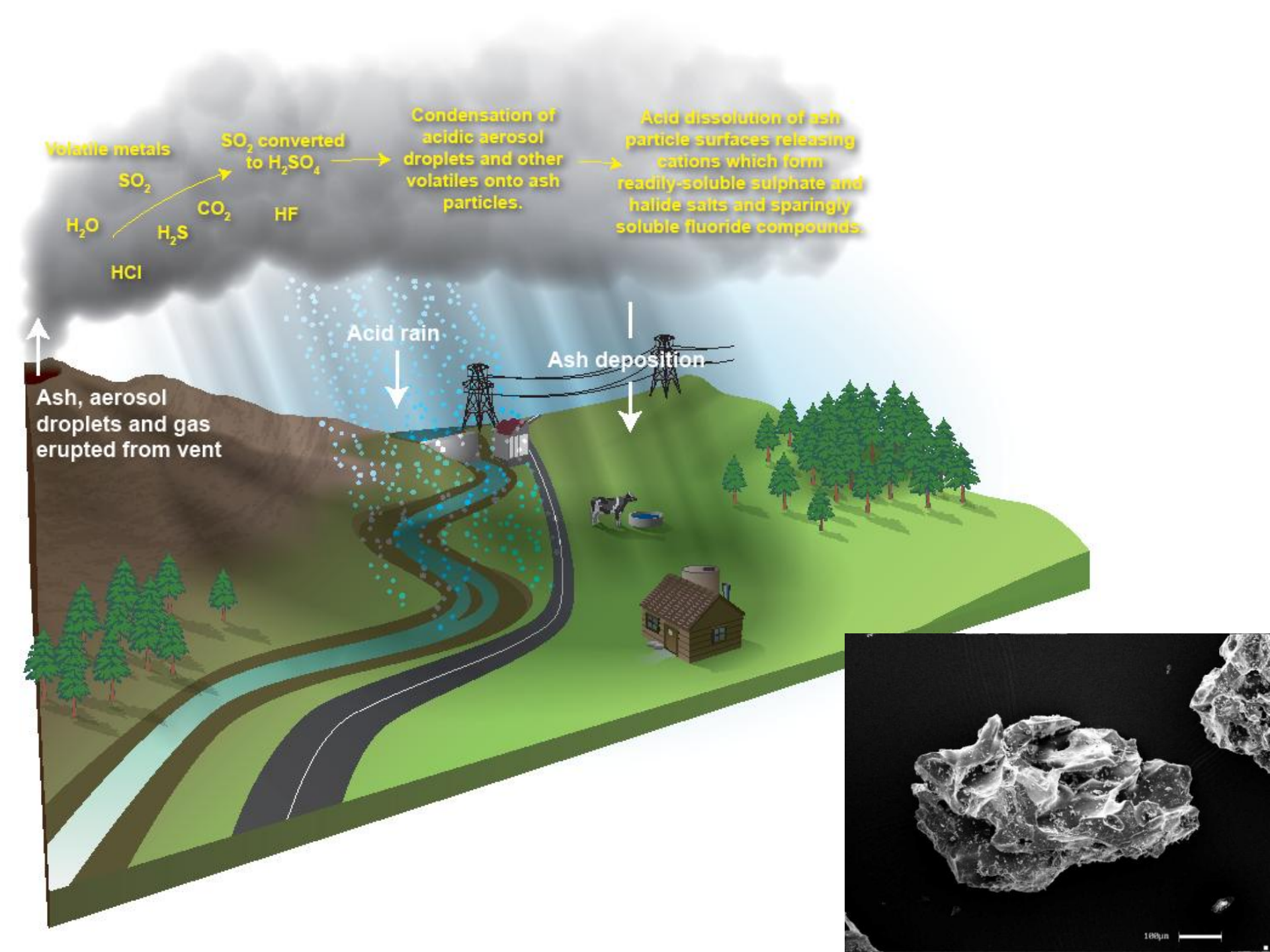
Andesitic ash, Ruapehu volcano, NZ

Basaltic tephra, Pacaya volcano, Guatemala

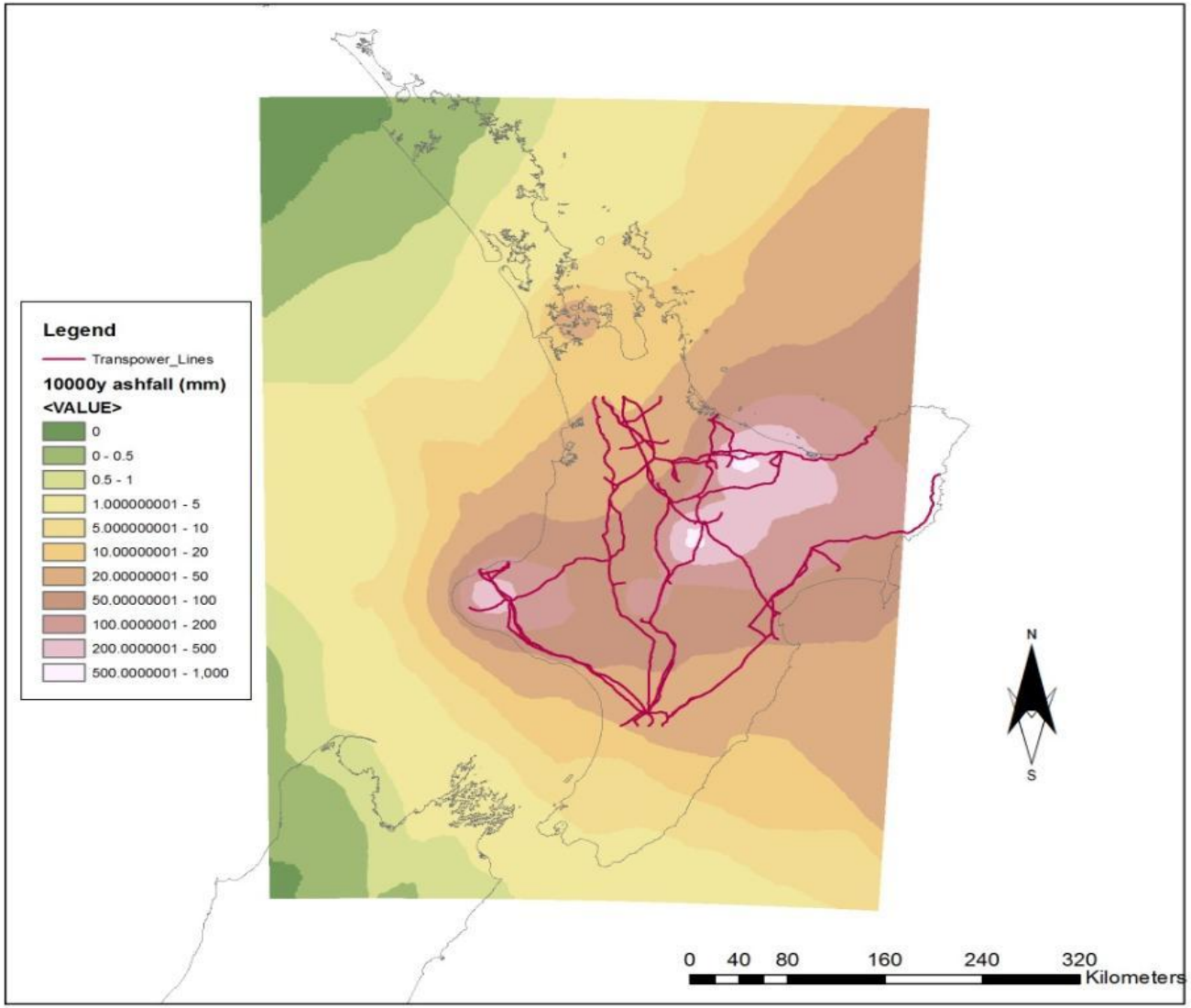
Grainsize distribution of tephra deposits changes with distance travelled





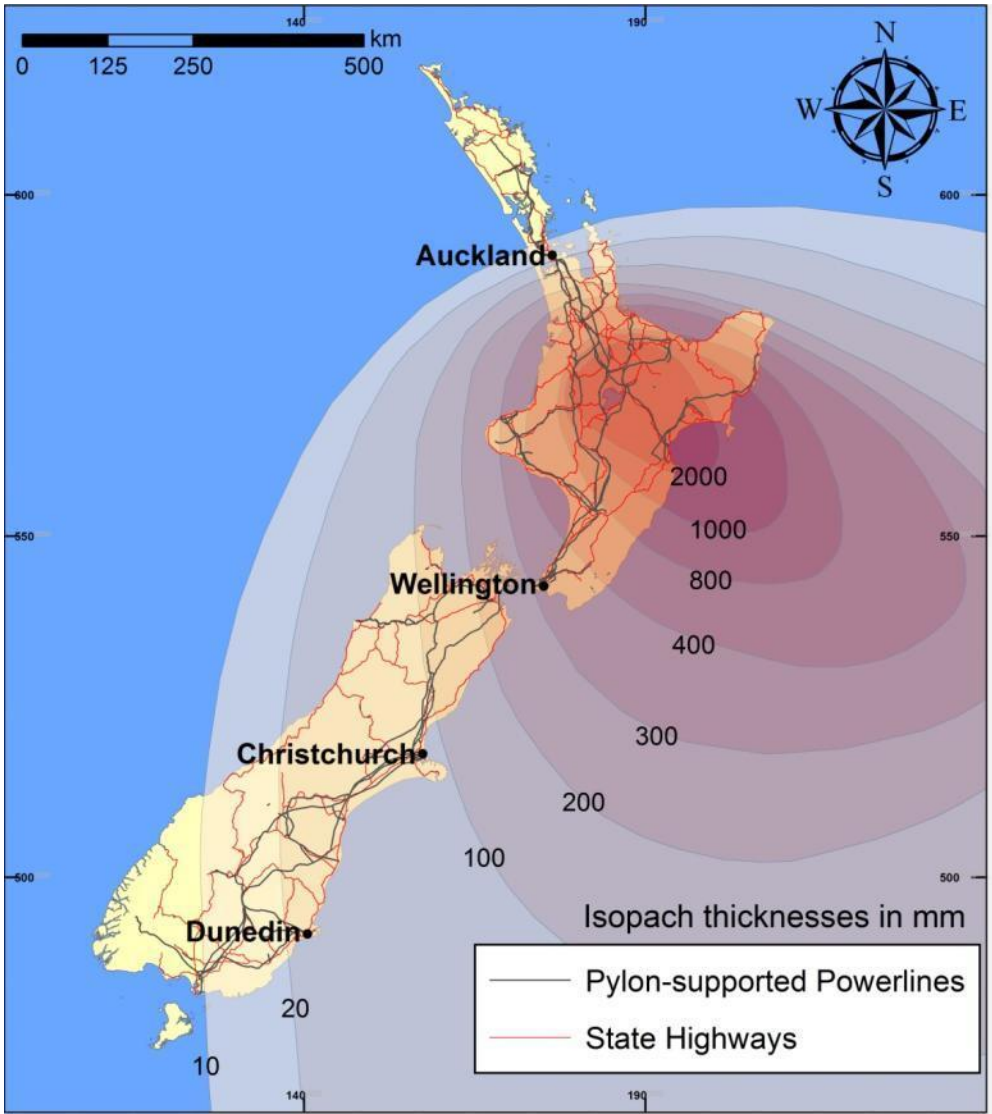

Volatile metals
SO_2
H_2O
CO_2
H_2S
HF
HCl
SO_2 converted to H_2SO_4
Condensation of acidic aerosol droplets and other volatiles onto ash particles.
Acid dissolution of ash particle surfaces releasing cations which form readily-soluble sulphate and halide salts and sparingly soluble fluoride compounds.
Acid rain
Ash deposition
Ash, aerosol droplets and gas erupted from vent
100µm

Ashfall hazard for Canterbury?



Oruanui eruption – 26.5ka

- Taupo Volcano
- 26.5 ka (thousand years ago)
- Ash fall
  - 430 km^3
  - Most of NZ effected
- Pyroclastic-density deposits
  - 320 km^3
  - 90 km run out from vent
  - Some flows >100 m/s
- Caldera
  - 140 km^2 structural collapse area
- References
  - Lowe et al. 2008
  - Wilson 2001



~100 mm in Canterbury...so what?

- Structural loading

- Public health concerns
  - Respiratory
  - Water
    - Contam (surface waters) + demand

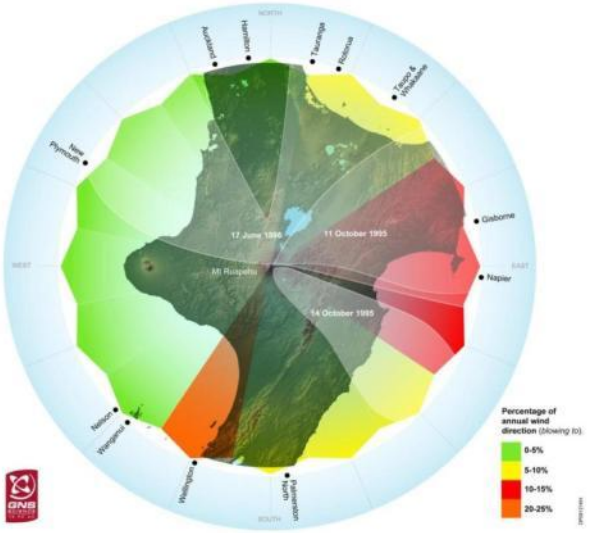
- Major clean up operation

- Transport Disruption

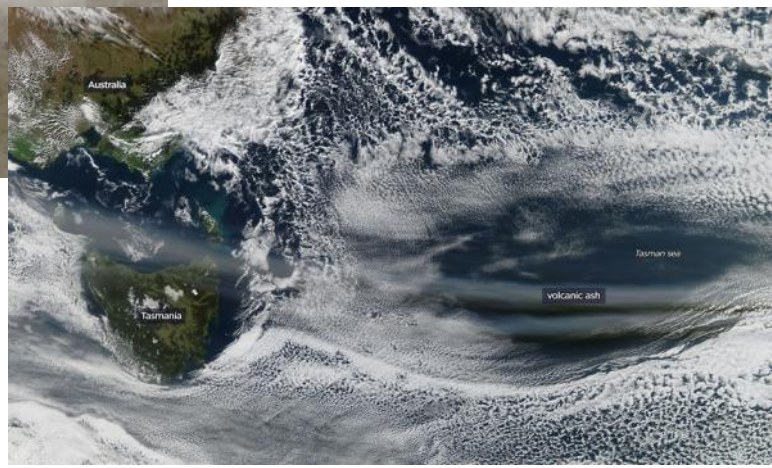
- Electricity Outages

- Severe agricultural impacts

Distal Ash Fall Impacts



13 June 2011

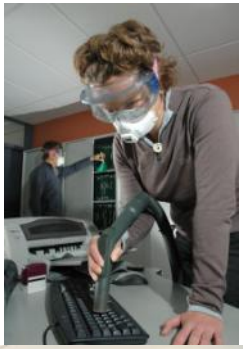


6 June 2011

NASA Aqua satellite images

~1-10 mm in Canterbury...so what?

- Structural loading



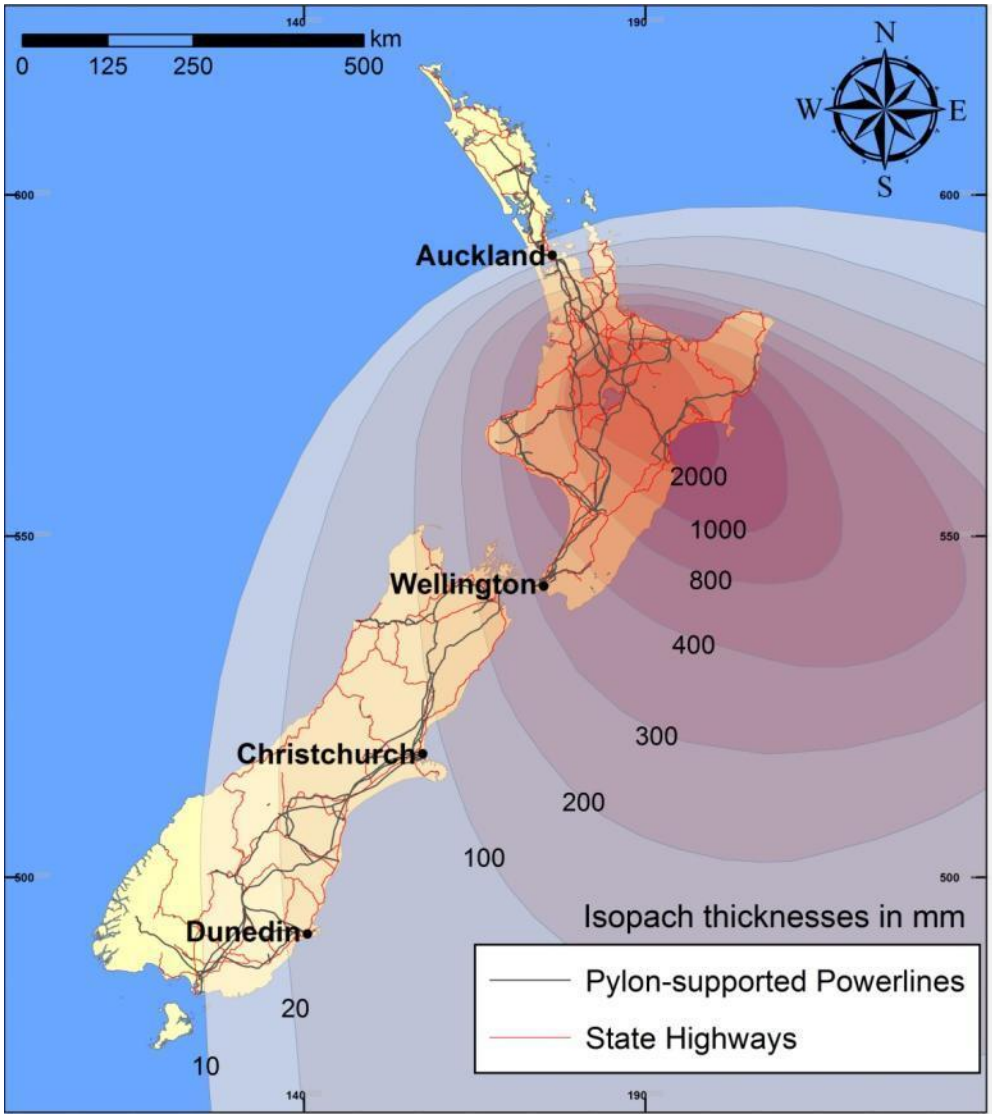
- Public health concerns
  - Respiratory
  - Water
    - Contam (surface waters) + demand

- Major clean up operation
- Transport Disruption
- Electricity Outages

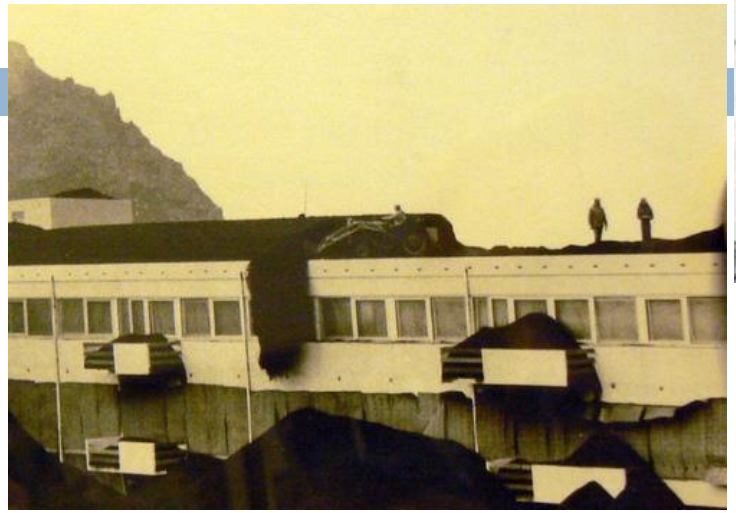
- Severe agricultural impacts

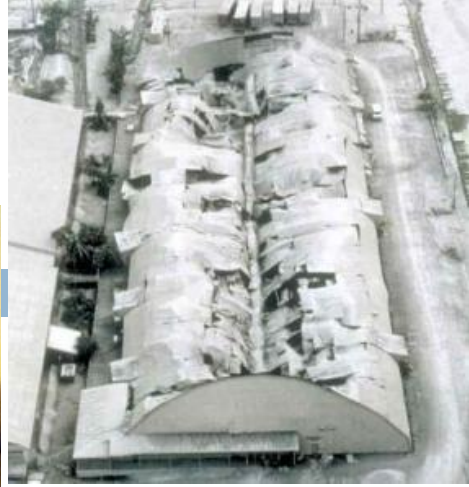
Oruanui eruption – Tephra Fall

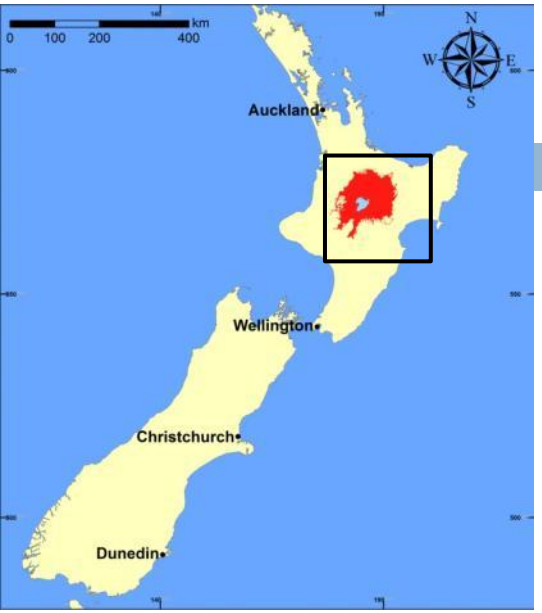
- Population (2006 census)
  - >300 mm: 1,533,390 (37.6%)
  - >100 mm: 1,782,921 (43.7%)
  - >10 mm: 3,716361 (91.03%)
  - Total NZ Pop. 2006: 4,082,505
- Infrastructure
- Agriculture

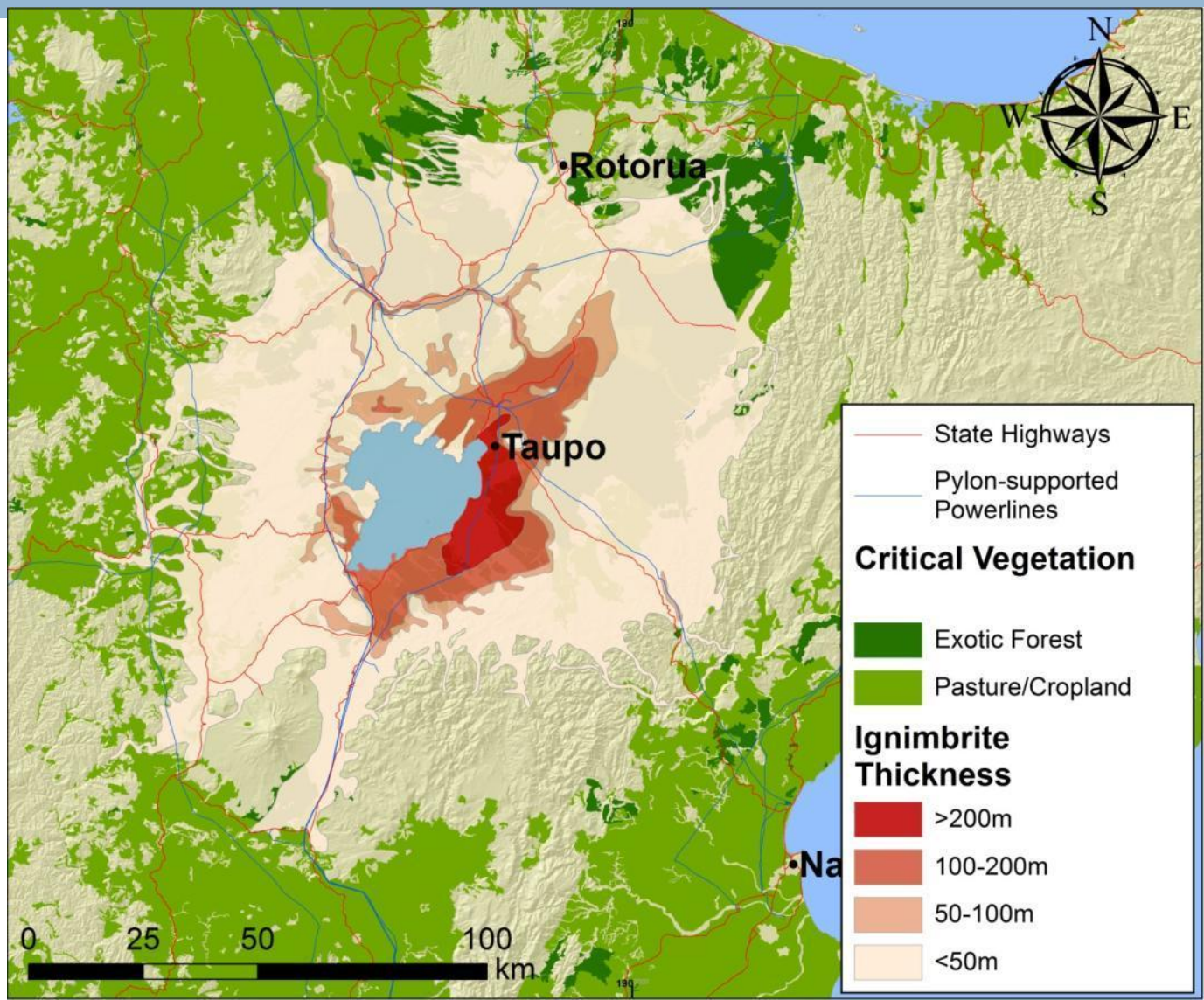


Thick Ashfall Impacts (<300 mm)





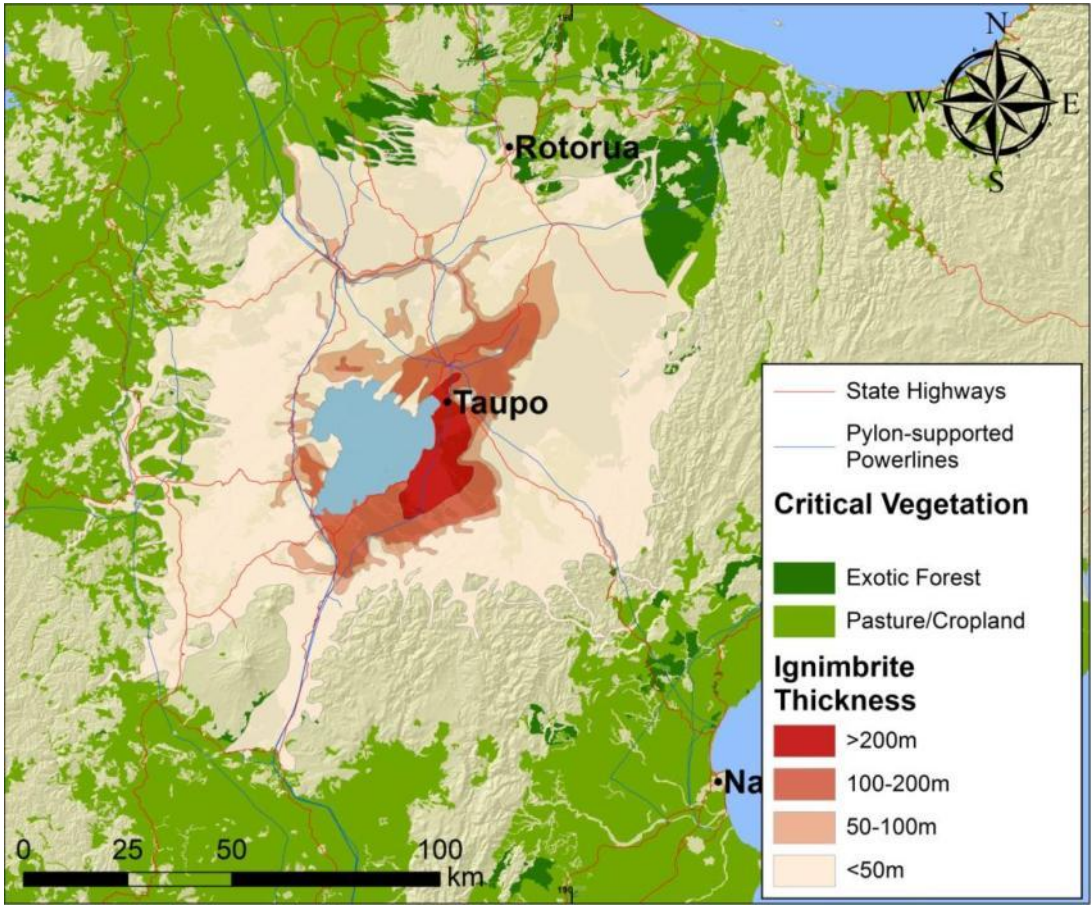

km
0
100
200
400
N
W
E
S
Auckland
Wellington
Christchurch
Dunedin


N
W
E
S
Rotorua
Taupo
0
25
50
100
km
State Highways
Pylon-supported Powerlines
Critical Vegetation
Exotic Forest
Pasture/Cropland
Ignimbrite Thickness
>200m
100-200m
50-100m
<50m

Pyroclastic flow impacts

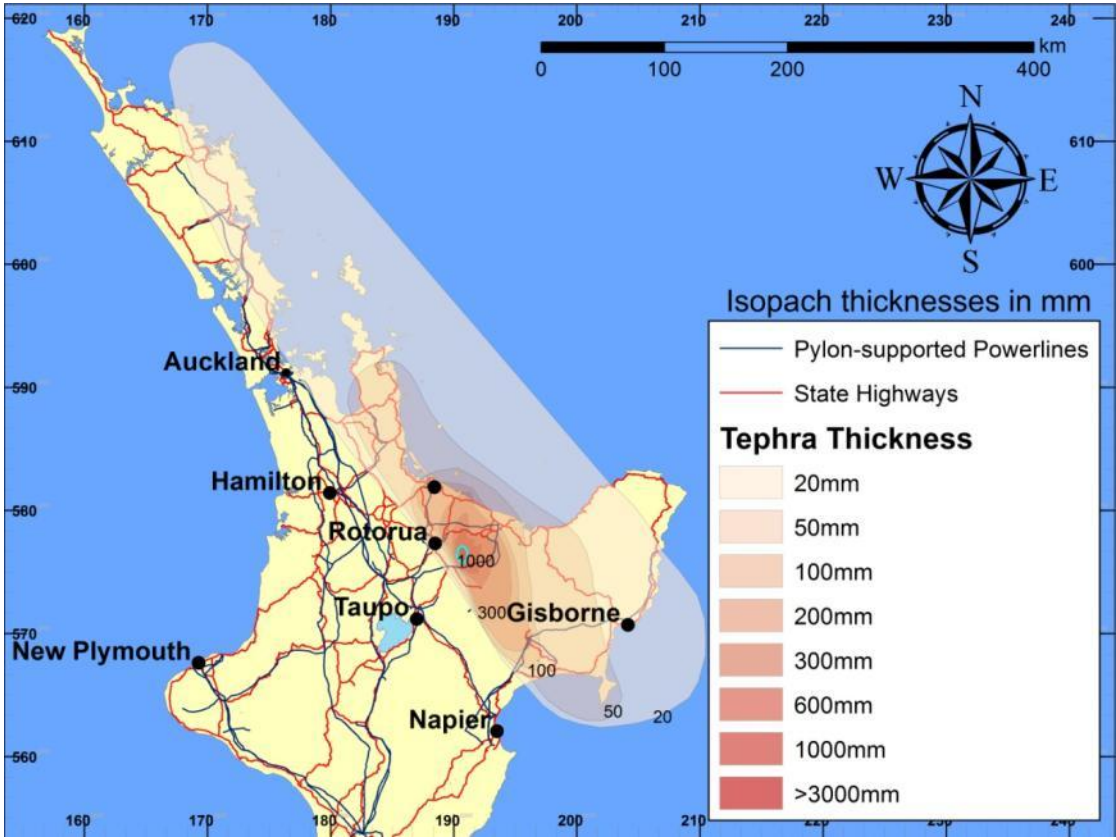
Oruanui eruption – PDC

- Population (2006 census)
  - >100 mm: 29,844 (0.73%)
  - >0 mm: 80,391 (2.0%)
  - Total NZ Pop. 2006: 4,082,505
- Infrastructure
  - 838 km of HV transmission lines
  - 2,567 km of sealed road
- Agriculture
  - 2,750 km^2 pasture/crop land
  - 1,483 km^2 production forestry



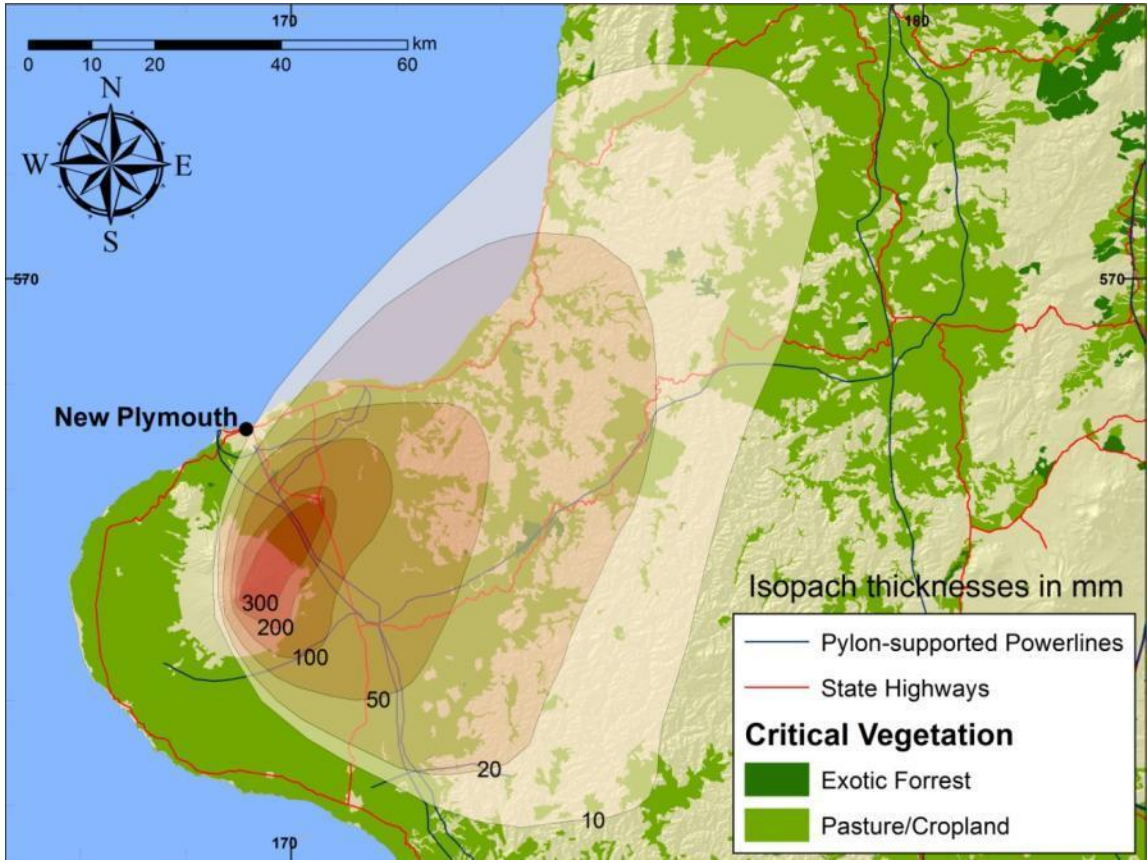
Kaharoa eruption – 1314 A.D.

- Tarawera volcano
- 5 km^3
- Population (2006 census) exposed to tephra fall
  - >300 mm: 22,485 (0.55%)
  - >100 mm: 202,050 (5.0%)
  - >20 mm: 647,613 (15.86%)
  - Total NZ Pop. (2006): 4,082,505

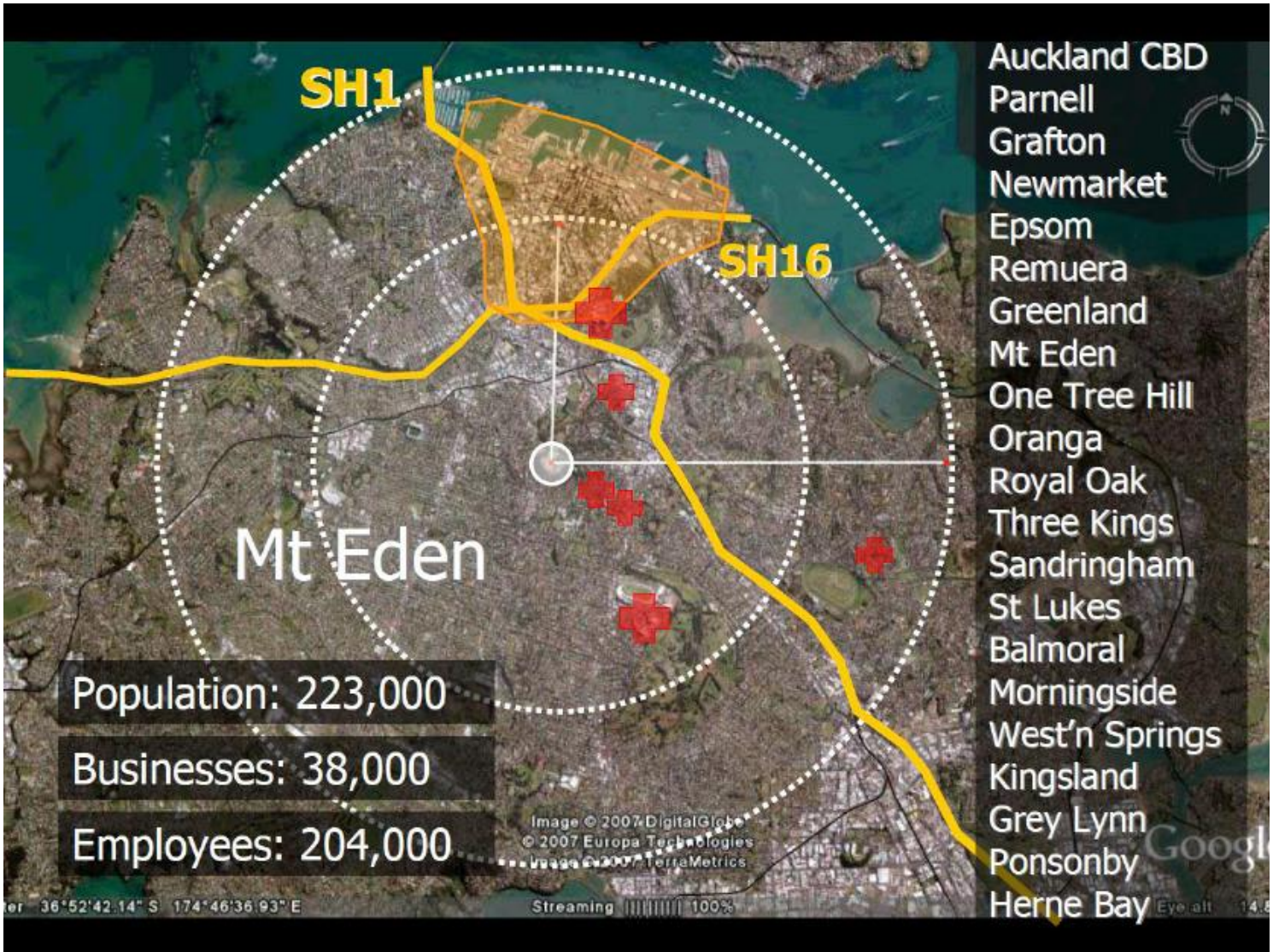


Inglewood eruption -

- Taranaki volcano
- >1 km^3
- Population exposed to tephra fall (2006 census)
  - >300 mm: 3,270 (0.08%)
  - >100 mm: 8,628 (0.21%)
  - >10 mm: 58,896 (1.44%)
  - Total NZ Pop. (2006): 4,082,505



Auckland Volcanic Field Eruption



Summary of key points

- Canterbury is exposed to volcanic fall risk.
  - Has happened before and will happen again

- Direct Impacts: Low probability, relatively low consequence

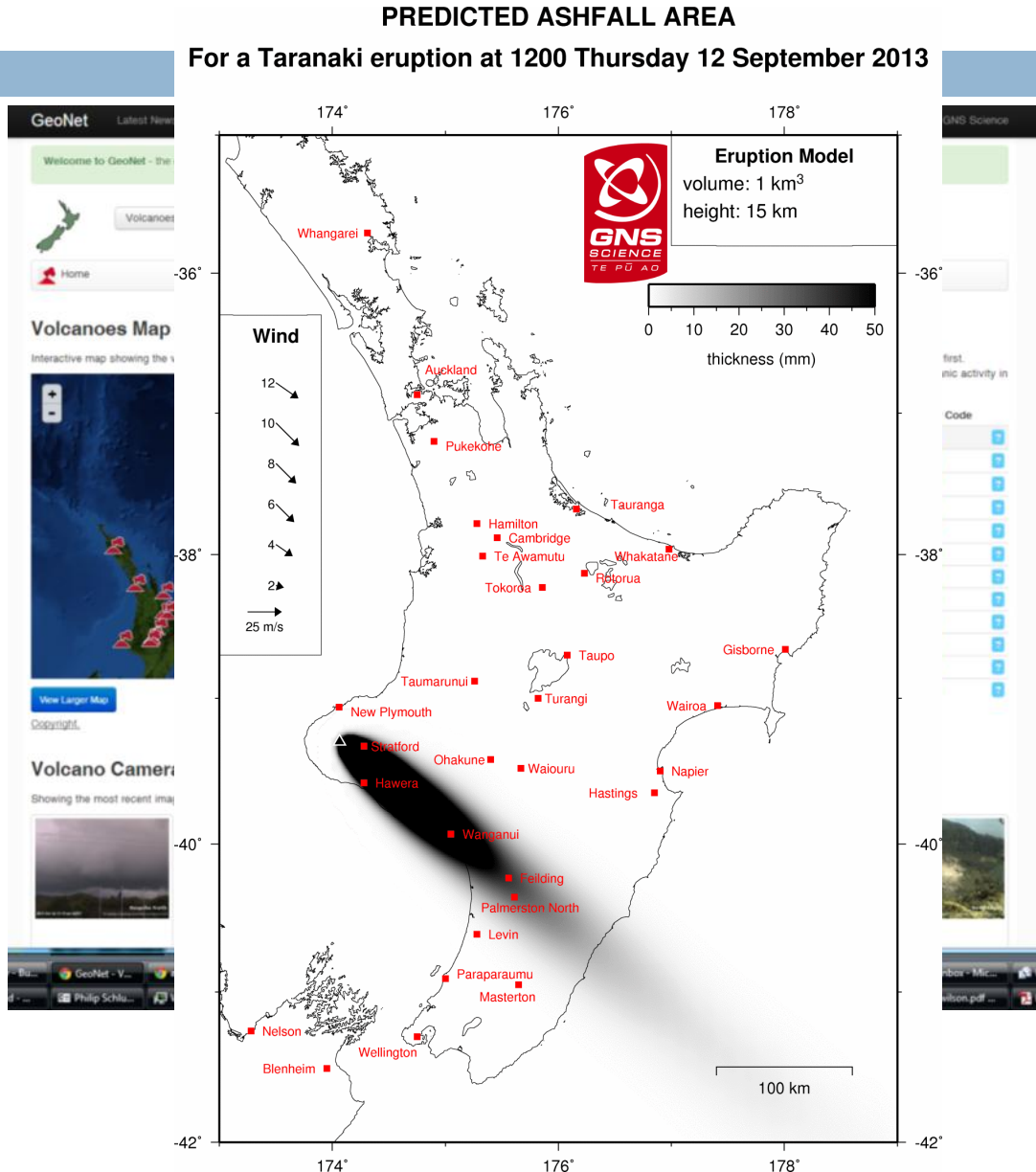
- Indirect Impacts: Evacuation destination and major support role
  - Before and During eruption
    - Evacuation and exclusion zones are the primary tool for managing life safety risk
      - population displacement
      - self evacuation/relocations (public health and economic opportunities)

  - During and After eruption
    - Impacts to physical and built environments means that land use change is also likely
      - retirement + de-intensification of land likely
      - population change + support for effected CDEM groups

GeoNet: 24/7 monitoring

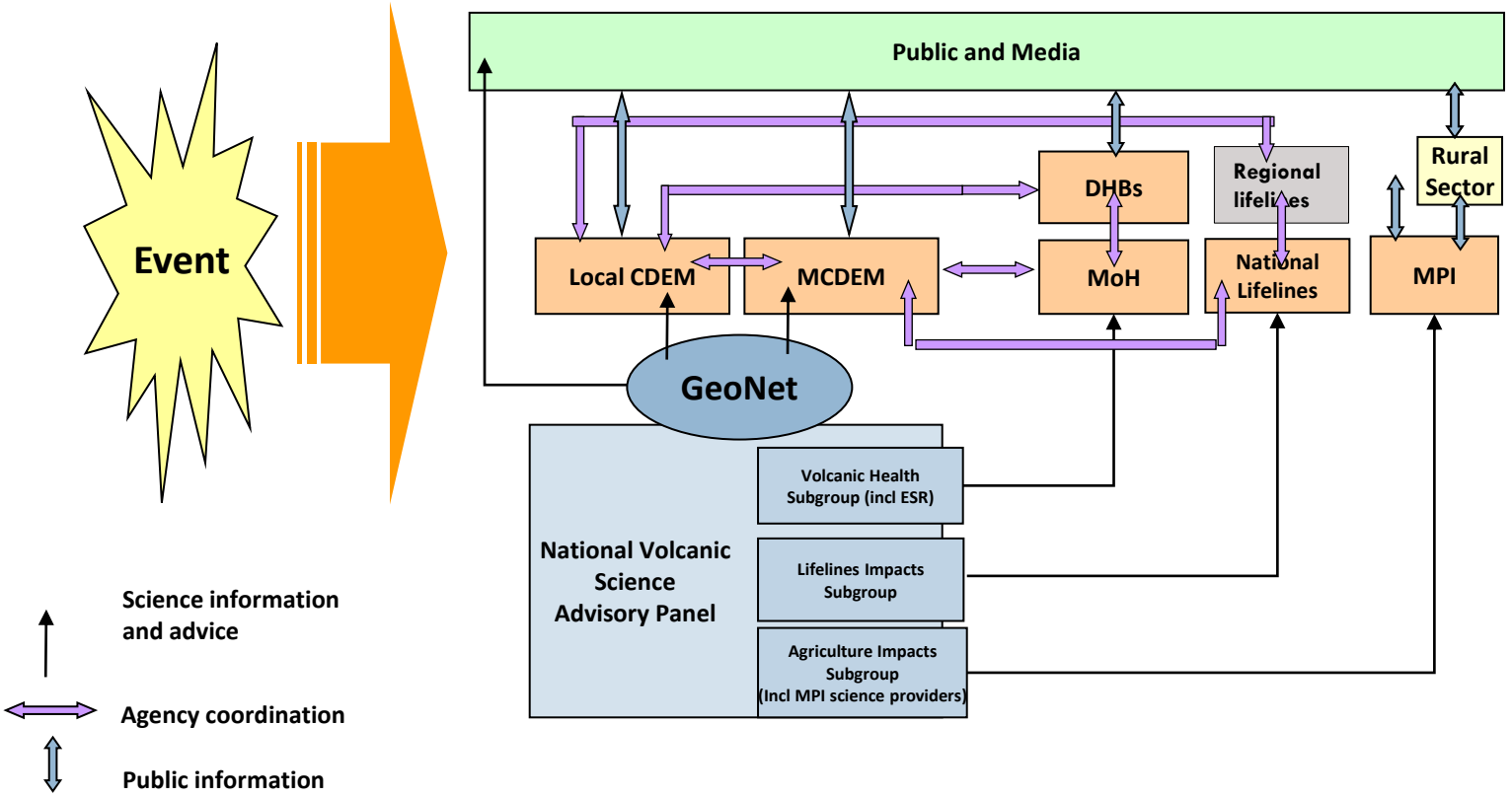
- Volcano Alert Level
- Aviation Colour Codes
- Volcano Alert Bulletins
- Ash forecasts,

http://www.geonet.org.nz/volcano/



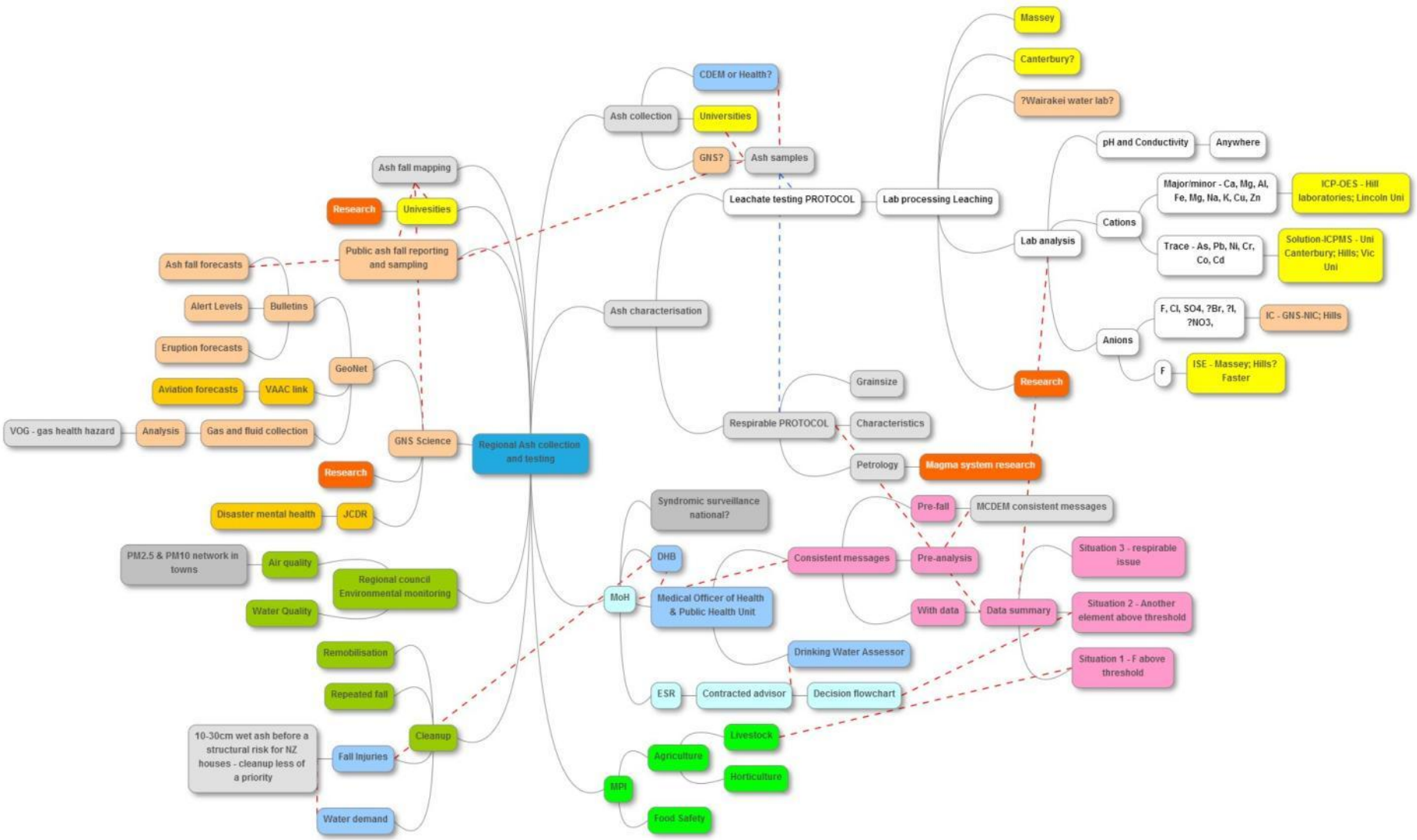
National Volcanic Science Advisory Panel: Comms./Coordin. plan DRAFT

- Incorporating agency science advisory arrangements with health and agriculture subgroups of NVSAP



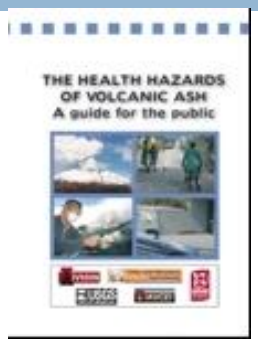
Courtesy of Richard Smith – EQC (formerly MCDEM)

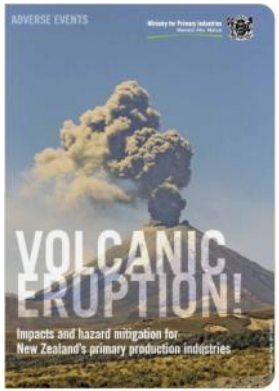
Ashfall Scientific Management



Volcanic Ash Preparedness Resources

- **GeoNet:** Volcano Alert Level, Aviation Colour Codes, Volcano Alert Bulletins, Ash forecasts,
  - http://www.geonet.org.nz/volcano/
- **One stop shops for impacts, preparedness & mitigation**
  - USGS/GNS Ash Impacts Website
    - http://volcanoes.usgs.gov/ash/index.html
  - GNS (point at from GeoNet)
    - http://www.gns.cri.nz/Home/Learning/Science-Topics/Volcanoes/Eruption-What-to-do/Ash-impacts
- **Health:** International Volcanic Health Hazard Network
  - http://www.ivhhn.org/
- **Infrastructure:** Auckland Engineering Lifelines: VISG
  - http://www.aelg.org.nz/volcanic-impacts/visg_home.cfm
- **Agriculture:** Ministry for Primary Industries
  - http://www.mpi.govt.nz/environment-natural-resources/funding-programmes/primary-sector-recovery/volcanic-eruptions





Any Questions?

Thanks to Cam Asher (UC)
for drafting figures

Exercise Ruaumoko, media inject 12 March 2008

Jan Lindsay

Significant natural hazard events in NZ's European history

1843 – Wanganui earthquake, M 7.2

1848 – Marlborough earthquake, M 7.8

1855 – Wairarapa earthquake, M 8.2

1868 – Chile tsunami, eastern NZ; Chatham Is, Christchurch – East Cape

1886 – Mt Tarawera eruption

1888 – Hanmer/north Canterbury earthquake, M 7.2

1901 – north Canterbury earthquake, M 7.2

1929 – Murchison/Buller earthquake, M 7.8

1931 - Napier/Hawkes Bay earthquake, M 7.8

1934 - north Wairarapa earthquake, M 7.4

1942 – Masterton earthquake, M 7.0

1945 – Ngauruhoe eruption

1960 – Chile tsunami, eastern NZ; Chatham Is, Christchurch – East Cape

1968 – Inangahua earthquake, M 7.4

1974/75 - Ruapehu eruptions

1987 – Edgecumbe earthquake, M 6.6. $240 M losses

1988 – Cyclone Bola. $200 M losses

1995/96 - Ruapehu eruptions. $133 M losses

2004 – Manawatu floods, $335 M losses – "150 yr return period event"

2010/11 – Canterbury earthquakes, M 7.1, 6.2, 6.0, 5.9

normal typeface ~ $500-900M in today's terms,
bold typeface ~ $1-10b,
large bold typeface > $10b in today's terms

Kelvin Berryman, Natural Hazards Research Platform